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FOREST SERVICE

OFFICE REPORT

MOUNTAIN PINE BEETLE EPIDEMIC AT JOSEPH CREEK BASIN MODOC NATIONAL FOREST

By

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This report summarizes the information gained from the studies and surveys made of the Joseph Creek Basin mountain pine beetle epidemic. The infestation, present in the stand for at least 13 years and epidemic for the last six of those years, subsided when precommercial thinning was completed. The primary source of information for this report is the thinning study begun in the winter of 1960-1961.

DESCRIPTION OF AREA

Joseph Creek Basin is a small valley northeast of Alturas, California on the west slope of the Warner Mountains. The floor of the Basin slopes gently to the west from an elevation of 6,000 feet to 5,400 feet. The vegetative cover varies from mixed ponderosa pine and white fir down through pure ponderosa pine to sagebrush and juniper. Between 600 and 700 acres out of the 1,000 acres on the floor of the Basin are timbered; the balance is irrigated pasture and sagebrush range-land.

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EXPERIMENT

The merchantable ponderosa pines in the Basin were logged between 1880 and 1900. Only a few overmature trees and some scattered groups of younger trees were left after logging. The present immature stand became established during the period of logging. The site index varies between SI 60 and SI 80 (Meyer's Yield Table, 100 year base). Before the beetle epidemic and thinning, there were 1,000 to 3,000 trees per acre, and basal area stocking varied from 200 to 400 square feet per acre with an average of 300 square feet.

HISTORY OF THE EPIDEMIC

Group killing of ponderosa pine poles by the mountain pine beetles was first reported in Joseph Creek Basin in 1953. Entomologists from the Pacific Southwest Forest and Range Experiment Station found that the mountain pine beetle activity was accompanied by minor secondary attacks of western pine and red turpentine beetles. (Figures 1, 2 and 3 are aerial photographs of Joseph Creek Basin in 1946, 1964 and 1967. Figure 4 shows the appearance of the stand from the ground.)

The Pacific Southwest Forest and Range Experiment Station kept the infestation under surveillance until 1961. At that time, insect detection and evaluation responsibilities were transferred to National Forest Administration, and surveillance was continued by Region 5 until the epidemic subsided.

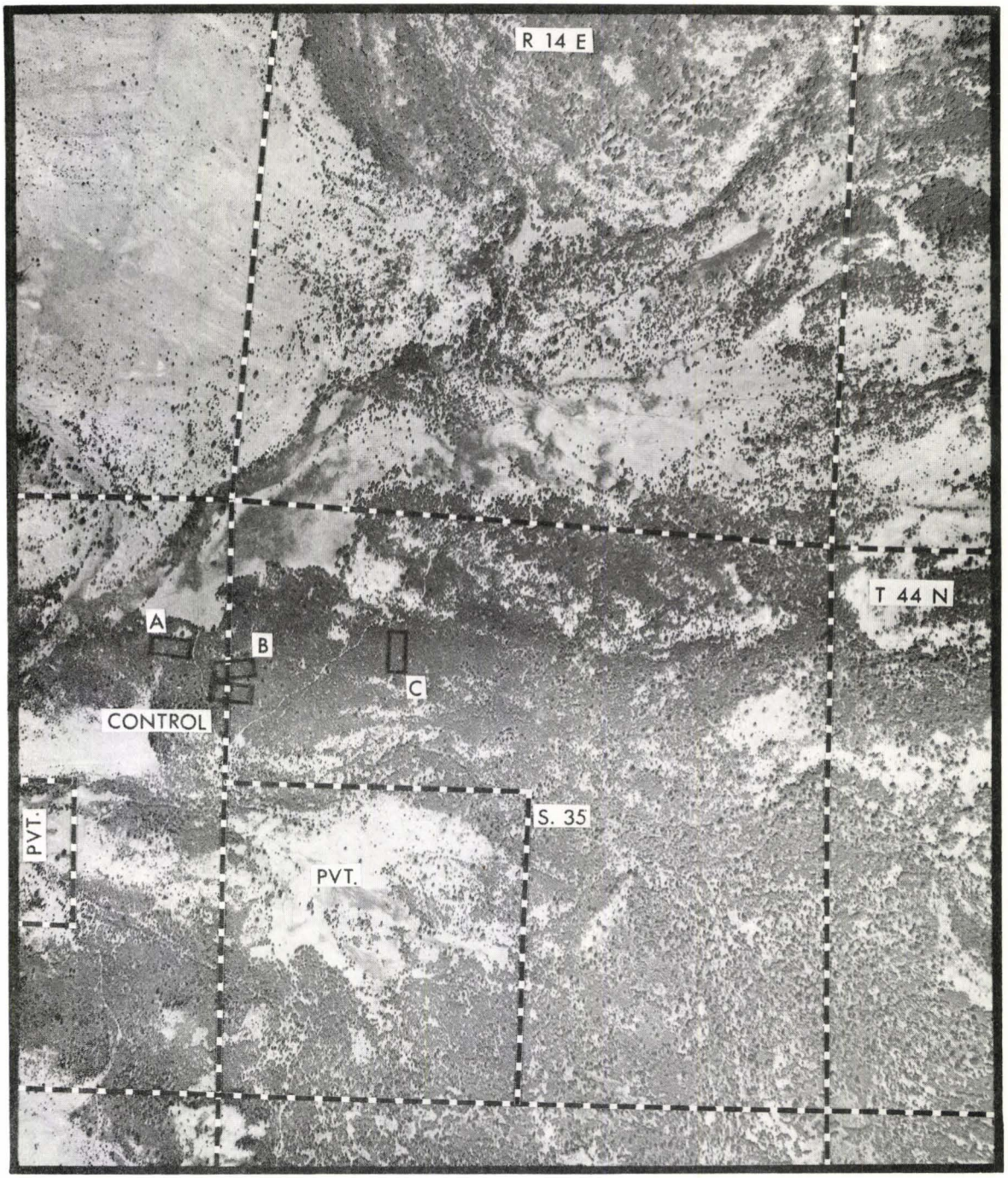

Figure 1. 1946 aerial photograph taken before any beetle losses and before thinning, enlarged to 4"=1 mile. Notice the scattered mature and overmature ponderosa pines left by logging. The understory trees are about 50 years of age. The locations of the thinning study plots A, B, C and Unthinned Control are shown in order to aid in comparison with subsequent photographs.

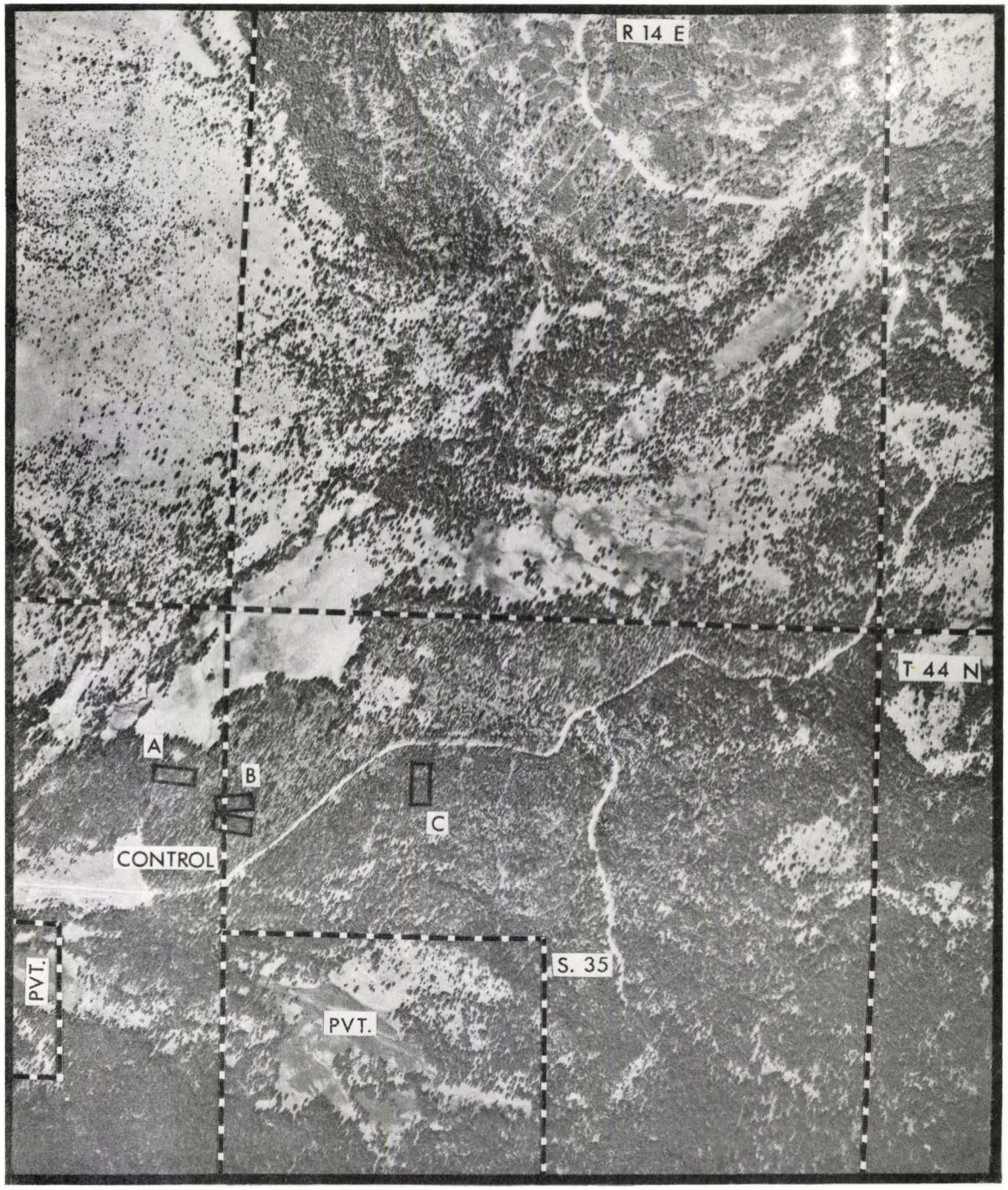

Figure 2. 1964 aerial photograph, the scale is 4"=1 mile. A large number of faded trees killed by 1963 beetle attacks are visible in Section 35. Compare incidence with progress of thinning shown in Figure 6.

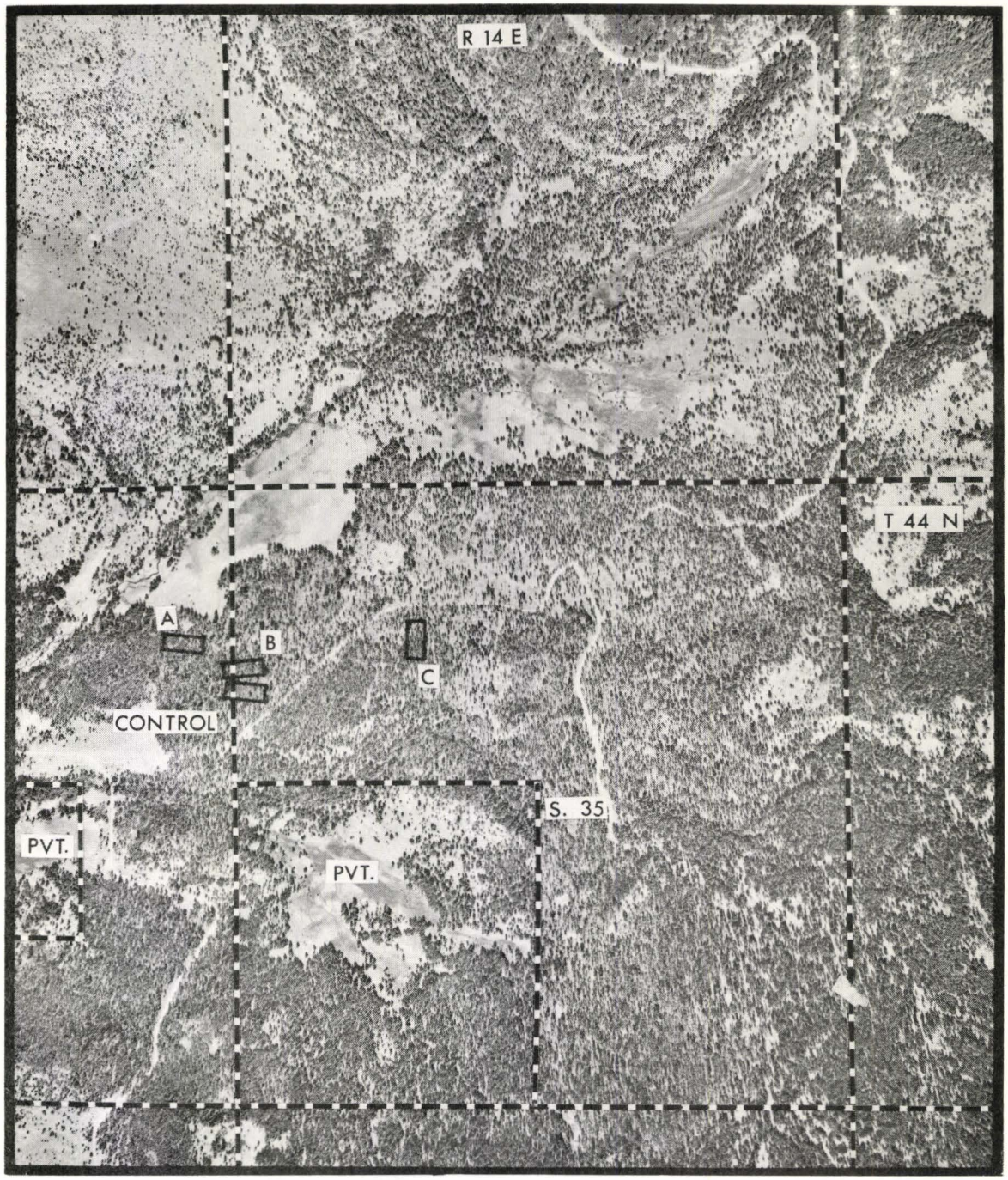

Figure 3. 1967 aerial photograph, the scale is 4"=1 mile. Thinning is complete and the epidemic has ended. The areas with high mortality as seen in Figure 2 have been cleared and the slash piled and burned. The unthinned stands near the right and lower margin of the photograph are predominantly white fir.

Modoc N.F. 8/1/61 #5 Joseph's Creek ponderosa pine pole stand thinned in groups by Dendroctonus monticolae beetles (and Dentroctonus valens).

Figure 4.

The mountain pine beetle infestation remained endemic until 1959 when, coinciding with the onset of a dry weather cycle, it grew rapidly into an epidemic. The epidemic reached its maximum in 1963, then declined in 1964 and 1965. By 1966, the infestation had returned to the endemic level with minor tree killing largely confined to unthinned stands on private land. The decline in the epidemic closely matched the progress of operational thinning in the Basin.

THINNING STUDY

Study Plan

The Administrative Thinning Study, undertaken to test thinning as a method of preventing epidemic losses from mountain pine beetle attacks, consisted of four one-acre plots, three of which were thinned and one left unthinned as a control. The thinning was done in December of 1960 and January of 1961. The thinning goal of 100 square feet of residual basal area was very nearly achieved. The basal area after thinning was 96 square feet on Plot A, 111 square feet on Plot B, and 102 square feet on Plot C. Each leave tree on the three thinned plots was numbered and its d.b.h. recorded. The trees on the control were not counted or measured; however, dead trees were cut in order to prevent confusion in future tree-loss observations. Readings on the four plots were taken annually.

In 1962, data were collected from 20 variable-radius plots in stands adjacent to the one-acre thinned plots. The purpose of this plot survey was to give a picture of the unthinned stand and to measure current insect losses. The basic data from this survey is shown in Table I.

Results

The response of the beetles to the thinning on the three plots was immediate. The first year after thinning only one tree was killed in Plots A and B while 43 were killed on the unthinned Control Plot. The Control Plot is close to Plots A and B, and other characteristics make these good for comparison. Over the five-year period after thinning, the number of trees on Plot A was reduced from 325 to 305; on Plot B from 262 to 240; and on the Control from several hundred to 43 trees 4 inches d.b.h. and larger. On Plot C, where the insect population pressure was greatest, the reduction was from 217 to 181 trees (Tables II and III).

An analysis was made of the variable-radius plot survey conducted in 1962. Three stand characteristics appear to be associated with tree mortality: original number of trees; original basal area; and average tree d.b.h. These associations are shown in Tables IV, V, and VI.

TABLE I

DATA ON TWENTY VARIABLE-RADIUS PLOTS, 1962
(Per Acre Basis)

Plot No.	Original Stand Data			Number Of Trees Killed			
	Basal Area (Sq. Ft.)	Average D.B.H. (Inches)	Number Of Trees	1962	1961	Prior To 1961	Total
1	360	7.9	2206	0	0	954	954
2	360	5.9	3358	66	0	2080	2146
3	240	7.4	960	560	0	160	720
4	420	5.7	5194	878	1486	1560	3924
5	260	11.5	558	0	0	0	0
6	220	10.7	474	26	0	190	216
7	140	11.1	250	0	0	0	0
8	220	8.6	822	0	0	0	0
9	300	8.8	1136	0	0	0	0
10	160	13.9	162	0	0	0	0
11	480	6.6	4956	2666	964	0	3630
12	340	7.7	1250	650	0	0	650
13	340	4.6	3742	74	0	230	304
14	320	14.0	408	306	0	26	332
15	280	10.7	596	218	146	204	568
16	280	11.6	602	16	508	32	556
17	380	13.1	1410	74	946	270	1290
18	200	12.6	282	12	18	184	214
19	120	17.0	182	0	76	0	76
20	200	12.0	360	0	18	110	118
Average	280	10.1	1445	277	208	300	785

TABLE II

THINNING STUDY
TREES KILLED FOLLOWING THINNING

Year	Years After Thinning	Thinned		Unthinned Control
		Plots A & B	Plot C	
1961	First	1	3	43
1962	Second	3	3	23
1963	Third	12	8	90
1964	Fourth	13	12	340
1965	Fifth	3	0	46
Total		32	26	542

TABLE III

THINNING STUDY
RESIDUAL TREES AFTER THINNING AND FIVE YEARS LATER

Plots	Original	Losses		Final
		Insects	Other 2/	
Thinned A	325	13	7	305
Thinned B	262	19	3	240
Thinned C	217	26	0	181
Unthinned Control	Not counted			43 1/

1/ Trees over 4" d.b.h. only.

2/ Mostly logging damage.

TABLE IV

ASSOCIATION OF ORIGINAL STAND DENSITY AND SUBSEQUENT INSECT-CAUSED LOSS

Ave. No. of Trees Per Acre	No. Plots	Ave. No. Trees Killed Per Acre 1955 to 1963
Less than 500	7	137
501 to 1,000	5	369
1,001 to 2,000	3	646
2,001 to 5,194	5	2,197

TABLE V

ASSOCIATION OF ORIGINAL BASAL AREA AND SUBSEQUENT INSECT-CAUSED LOSS

Original Basal Area	No. Plots	No. Trees Killed Per Acre
100 - 200	5	82
201 - 300	7	294
301 - 400	6	946
401 - 500	2	3,792

TABLE VI

ASSOCIATION OF AVE. DBH AND SUBSEQUENT
INSECT-CAUSED LOSS

Range DBH Inches	No. Plots	Ave. No. Trees Killed Per Acre
4 to 6	4	2,501
7 to 9	5	465
10 to 12	7	239
Above 12	4	420

TABLE VII

PHLOEM MOISTURE
DOMINANT TREES ON THINNED AND UNTHINNED AREAS

Treatment	Tree No.	DBH	Phloem Moisture Percent At Oven Dried Weight
Unthinned	1-A	10.1	133
	1-B	10.1	152
	2-A	12.1	122
	2-B	12.1	110
	3-A	12.3	137
	3-B	12.3	136
Average			132
Thinned	1-A	10.4	134
	1-B	10.4	143
	2-A	11.8	211
	2-B	11.8	191
	3-A	12.3	225
	3-B	12.3	223
	4-A	11.6	191
	4-B	11.6	196
Average			189

In 1962, soil moisture and phloem moisture samples were taken at Joseph Creek. The available soil moisture was not significantly different between thinned and unthinned areas; however, the phloem moisture was significantly greater in trees in the thinned area. (Table VII for Phloem Moisture data.)

Diameter growth increased rapidly following thinning (Figure 5). The rapid diameter growth response indicates that the stands were not stagnated, just over-dense.

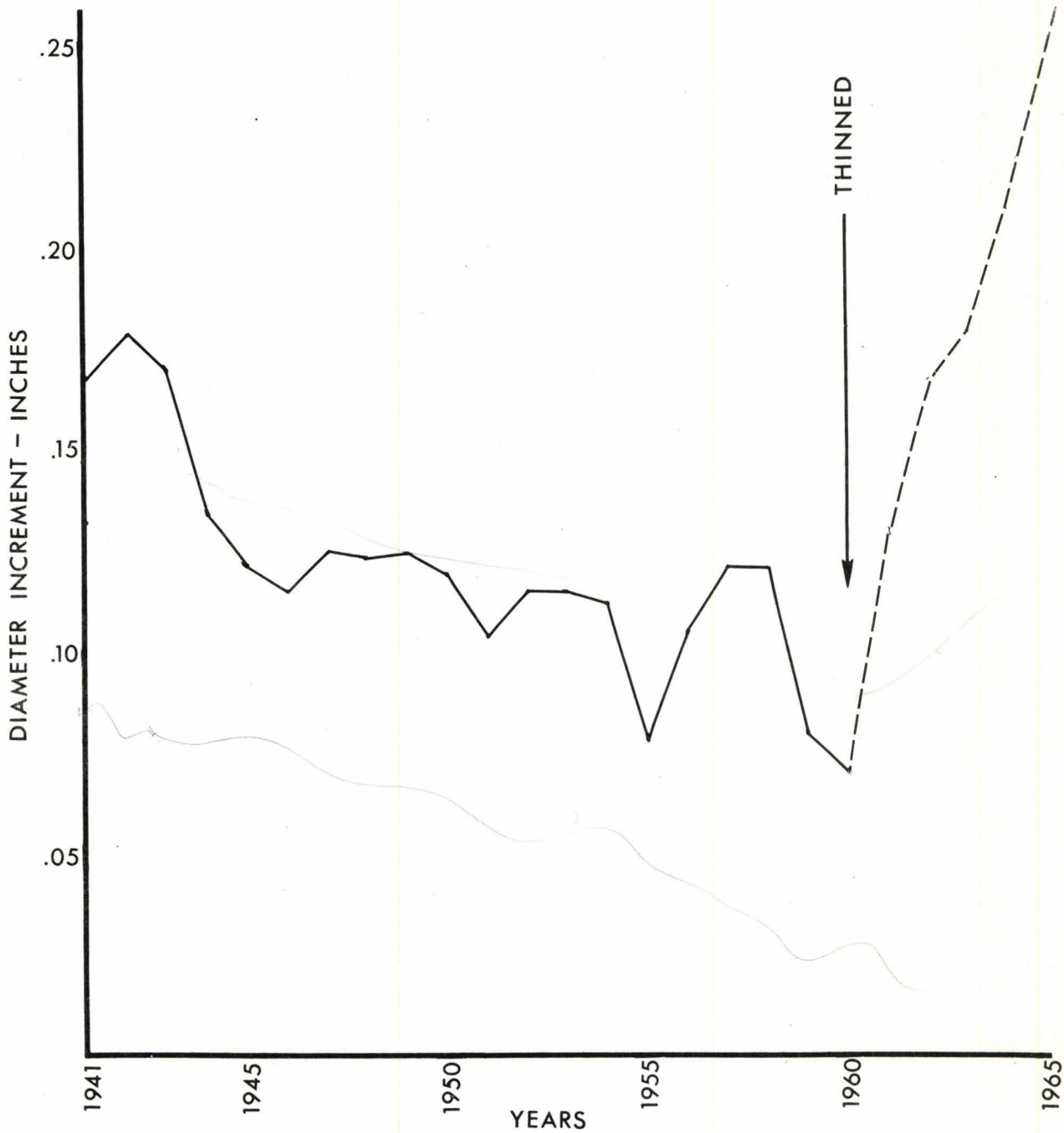

Figure 5. Diameter Increment on Thinned Plots
Core data from 20 residual trees on thinned plots A and B. Thinning was done prior to 1961 growing season.

OPERATIONAL THINNING

The immediate and highly satisfactory results in reducing insect losses by thinning encouraged the Forest to begin operational thinning in the remaining stands in Joseph Creek Basin, and the first of a series of thinning contracts was issued in December of 1962. During the next four years, 760 acres of dense stands of ponderosa pine were thinned in and adjacent to Joseph Creek Basin to control the mountain pine beetle infestation.

In the fall of 1963, the Forest became concerned because the thinned area seemed to be sustaining heavier insect losses than would have been predicted from the study plots. A survey was made of the thinned area in which a 100 percent tally was made of infested trees. The data were analyzed according to the time of thinning (Table VIII and Figure 6). The conclusion drawn from the data was that the high losses were largely confined to the area thinned after spring beetle emergence and attack of reserve trees.

In conjunction with the above survey a 10 percent survey was made of the remaining unthinned stands. These results showed that the stands thinned in 1963 had an average loss of 21 trees per acre compared to an estimated loss of 79 trees per acre in the unthinned stands.

Studies were also conducted in the early spring of 1964 when the over-wintering population of the mountain pine beetle was sampled on 15 randomly selected infested trees. All stages of the brood were counted in 1/2-foot-square bark samples at four levels in each tree. These data showed an estimated population of larvae and pupae of 57 per square foot of bark area. It was further estimated that there were about 30,000 infested trees in the area from which beetles would emerge in late spring of 1964. The population count and the number of infested trees indicate a very heavy population pressure for the area.

The first thinning contract required the contractor to cut only green unmarked trees below 8" d.b.h., which left some stands inadequately thinned and a great many insect-killed trees standing, which, in turn, may have contributed to the continuing insect losses. Subsequent thinning prescriptions provided for cutting green unmarked trees up to 12 inches d.b.h. and all standing dead trees. Thinning was completed in the Basin in 1966.

TABLE VIII

THE EFFECT OF TIME OF THINNING
ON SUBSEQUENT LOSS[1/]

Approximate Time Of Thinning	Subsequent Loss (Trees Per Acre)
Midwinter	5
Late Winter	7
Spring	31
Early Summer	61
Average	21

1/ 100 acres of thinning analyzed--4 units of approximately 25 acres each.

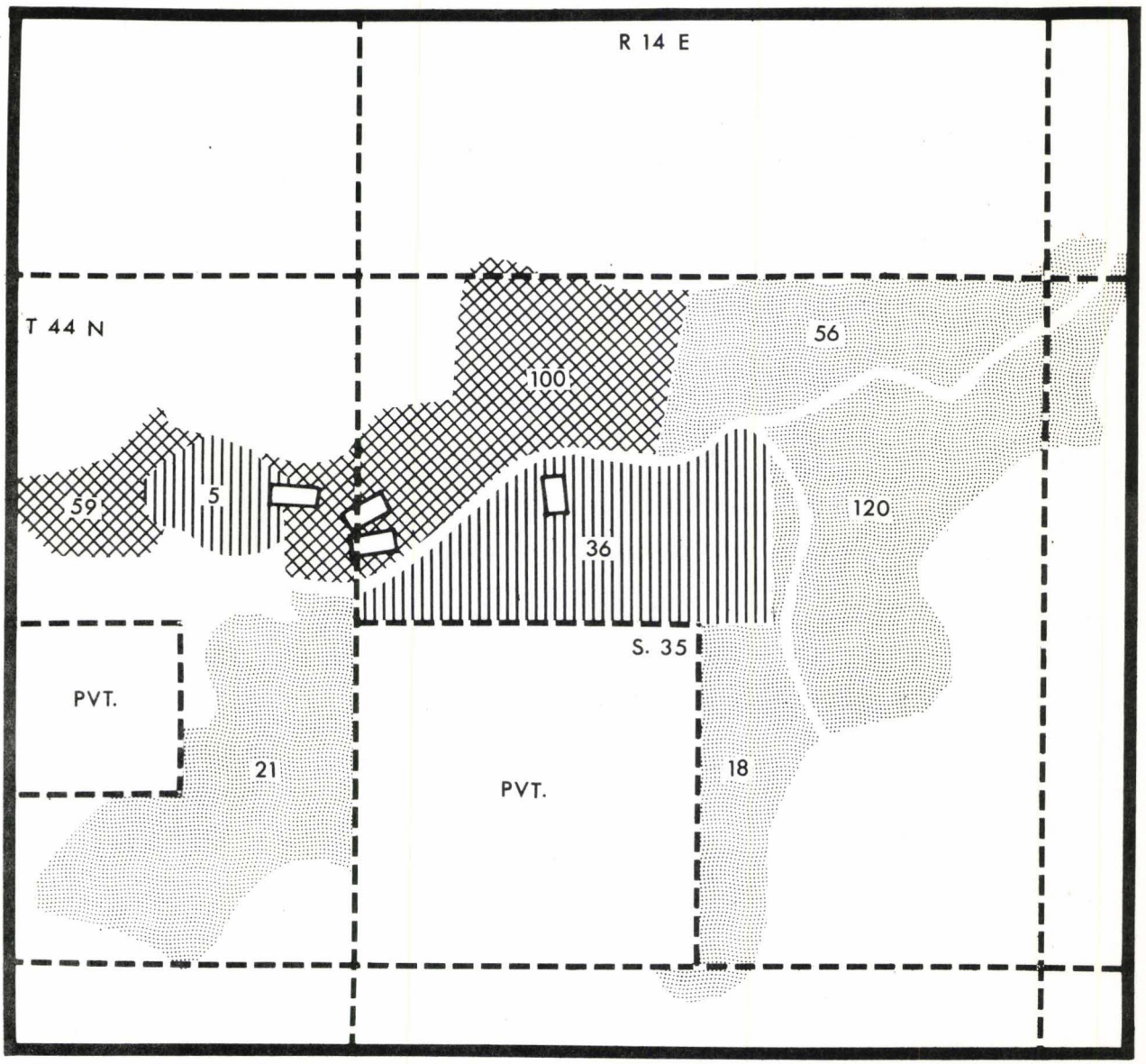

Figure 6. Status of Thinning - January 1, 1964

Contract thinned prior to August 1963

Contract thinned after August 1963

Unthinned

23 Number of infested ponderosa pine trees per acre

Scale 4"= 1 mile

DISCUSSION

At Joseph Creek, tree loss due to mountain pine beetle attacks was significantly reduced by thinning. The measurements of phloem moisture and diameter growth seem to indicate that the reduction in losses was due to increased tree vigor. Experience in working with these stands indicates that environmental changes other than soil and phloem moisture may be equally important. First, the beetles remained active in unthinned stands long after earlier beetle attacks had reduced the number of live trees to a point where there were not enough trees to use up the available soil moisture. Second, the beetles emerging in the spring avoided recently thinned stands, even though the thinning was too recent for the trees to have responded to thinning, and when moisture was more than adequate for both thinned and unthinned stands. It was not that the leave trees were able to resist attacks by pitching the beetles out, but rather that there were very few attacks.

Some of the environmental changes caused by thinning are increased light penetration, increased temperatures, and increased air movement. Thinning may also disrupt the typical tree group pattern of beetle attack.

RECOMMENDATIONS

The mountain pine beetle at Joseph Creek could be considered a method of natural thinning. However, there are some aspects of this type of thinning which make it unsatisfactory in a managed forest. First, the beetles attack trees in groups, in which all the trees are killed irrespective of vigor or crown class, the best trees being killed along with the poorest. Second, tree killing continues until only very few trees are left, a point far below desired stocking. In contrast, thinning with a chain saw removes many trees, but the best trees are left, and in sufficient numbers to provide adequate stocking.

Thinning is an effective management tool in reducing tree mortality caused by the mountain pine beetle in overstocked young stands of ponderosa pine. From the experience at Joseph Creek, it would appear that thinning was used too late in order to achieve maximum results. Although mortality was significantly reduced, major damage to the stand had occurred before thinning. The growth curve indicates that thinning should have started by 1945.

If factors other than tree vigor are involved in the resistance to insect attack, chemical thinning, which leaves the trees standing,

may be unsuccessful because the stand environment is not sufficiently changed. More study of mountain pine beetle behavior is needed to show why thinning is successful.

Although it may be sometime before the specific reason for the success of thinning is discovered, there should be no delay in thinning other potential "Joseph Creeks" in order to prevent future mountain pine beetle epidemics.

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